BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

As rescanning documents *will not* correct images, please do not report the images to the Image Problem Mailbox.

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 552 624 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **93100257.0**

(51) Int. Cl.5: **A61K 31/20, A61K 31/07**

(22) Date of filing: **11.01.93**

(30) Priority: **22.01.92 US 823741**
22.01.92 US 823786
22.01.92 US 823928
23.01.92 US 824647

(43) Date of publication of application:
28.07.93 Bulletin 93/30

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IE IT LI LU MC NL PT SE

(71) Applicant: **F. HOFFMANN-LA ROCHE AG**
Postfach 3255
CH-4002 Basel(CH)

(72) Inventor: **Bollag, Werner**
10 Mythenstrasse
CH-4054 Basle(CH)
Inventor: **Grippo, Joseph Francis**
63 Woodstone Road
Basking Ridge, N.J. 07920(US)
Inventor: **Levin, Arthur**
132 Stonehouse Road
Glen Ridge, N.J. 07028(US)

(74) Representative: **Grossner, Lutz, Dr. et al**
Grenzacher Strasse 124 Postfach 3255
CH-4002 Basel (CH)

(54) Pharmaceutical compositions containing 9-cis retinoic acid, salts and esters thereof.

(57) 9-cis retinoic acid, its salts and esters can be used in the treatment of malignant and premalignant epithelial lesions, skin photodamage, disorders caused by increased sebum production, and psoriasis.

EP 0 552 624 A1

The present invention is concerned with novel pharmaceutical compositions containing 9-cis retinoic acid, pharmaceutically acceptable salts and pharmaceutically acceptable hydrolyzable esters thereof.

Furthermore, the invention is concerned with 9-cis retinoic acid, its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters for use as a medicament.

In another aspect, the invention is concerned with the use of 9-cis retinoic acid, its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters in the manufacture of a medicament for medical indications as defined below.

In accordance with this invention, it has been found that 9-cis retinoic acid, its pharmaceutically acceptable salts or its pharmaceutically acceptable hydrolyzable esters possess with regard to epithelial lesions, antihyperplastic, antimetaplastic, antineoplastic tumor-preventative and tumor-therapeutic properties exhibiting limited toxicity or other adverse effects associated with retinoids. It has now been found that pathological conditions treatment of which involves the above properties can be effectively treated by administering 9-cis retinoic acid, its pharmaceutically acceptable salts or its pharmaceutically acceptable hydrolyzable esters either systemically or topically.

In accordance with one embodiment of this invention, 9-cis retinoic acid, its pharmaceutically acceptable salt or its pharmaceutically acceptable hydrolyzable esters when administered to mammals having premalignant epithelial lesions, i.e., precancerous lesions, retards the progression of the lesions. This compound controls the cellular growth and differentiation of these premalignant or precancerous lesions and causes cellular repair. In this way, the development of these lesions into epithelial carcinomas is prevented.

In treating premalignant or precancerous epithelial lesions to retard the progression of these lesions into carcinomas, 9-cis retinoic acid, its pharmaceutically acceptable salts or its pharmaceutically acceptable hydrolyzable esters is administered either orally or topically to patients affected by these lesions in an amount effective for retarding the progression of these lesions. The amount will be dependent on the amount and size of the lesions and on the requirement of the patient.

9-cis retinoic acid its pharmaceutically acceptable salts or its pharmaceutically acceptable hydrolyzable esters is especially effective in treating premalignant or precancerous lesions of an epithelial nature of the breast, cervix, prostate, skin, colon, bladder, esophagus, stomach, larynx, lung or oral cavity. In accordance with a preferred embodiment, this compound can be utilized to treat premalignant or precancerous lesions such as various leukoplakias, especially that of the mouth and tongue, as well as precancerous or premalignant lesions of the breast.

In accordance with a further embodiment of this invention, 9-cis retinoic acid, its pharmaceutically acceptable salts or its pharmaceutically acceptable hydrolyzable esters can be utilized to treat carcinomas or tumors of epithelial origin to retard the development of these tumors. In accordance with the anti-carcinoma or anti-tumor properties of this compound, treatment of the tumors with this compound produces a regression in both the size and number of these tumors. In utilizing this compound as an anti-tumor agent, this compound is especially effective in retarding the development of tumor of the breast, cervix, prostate, skin, colon, bladder, esophagus, stomach, larynx, lung or mouth. 9-cis retinoic acid can be administered to patients in the manner described above in connection with treating patients having premalignant or precancerous lesions.

For the treatment given above, 9-cis retinoic acid its pharmaceutically acceptable salts or its pharmaceutically acceptable hydrolyzable esters is administered either systemically or topically as a composition containing 9-cis retinoic acid and a pharmaceutically acceptable carrier compatible with said compound. In preparing such composition, any conventional pharmaceutically acceptable carrier can be utilized. When the drug is administered orally, it is generally administered at regular intervals, conveniently at mealtimes or once daily. It has been established that this compound is relatively non-toxic when given topically and when given orally.

Examples of conditions involving premalignant and precancerous epithelial lesions or tumors which are effectively treated with 9-cis retinoic acid are actinic keratoses, arsenic keratoses, xeroderma pigmentosum, Bowen's disease, leukoplakias, metaplasias, dysplasias and papillomas of mucous membranes, e.g. of the mouth, tongue, pharynx and larynx, precancerous changes of the bronchial mucous membrane such as meta-plasias and dysplasias (especially frequent in heavy smokers and people who work with asbestos and/or uranium), dysplasias and leukoplakias of the cervix uteri, vulval dystrophy, precancerous changes of the bladder, e.g. metaplasias and dysplasias, papillomas of the bladder as well as polyps of the intestinal tract. Examples of tumors or carcinomas of semi-malignant or malignant nature, of the epithelial origin which are effectively treated by 9-cis retinoic acid are breast tumors, cervical and prostate tumors, skin tumors, e.g. basal cell carcinomas, bladder tumors, e.g. superficial bladder carcinomas, colon tumors, esophageal tumors, stomach tumors, laryngeal tumors and lung tumors.

The treatment of precancerous lesions and malignant tumors of epithelial nature can be effected with 9-cis retinoic acid its pharmaceutically acceptable salts or its pharmaceutically acceptable hydrolyzable esters alone or in combination with other measures such as surgery, radiation therapy, hormone therapy or treatment with standard chemotherapy (cytostatic and cytotoxic agents) or biological response modifiers (interferons, interleukins or other cytokines).

Furthermore, in accordance with this invention, it has been found that 9-cis retinoic acid and pharmaceutically acceptable salts and hydrolyzable esters thereof applied topically to the skin of a patient reverses the conditions associated with photodamage. Hence, by the topical application of compounds of formula I to the skin of patients which has been damaged through sun exposure, the effects of wrinkling, elastosis and premature aging can be reversed leading to an improvement in the appearance of the skin.

Through the topical administration of the compounds of the formula I and pharmaceutically acceptable salts and hydrolyzable esters, the acceleration of repair of dermal damage is accomplished so as to provide the skin with a smoother and younger appearance.

In accordance with this invention, it has also been found that when 9-cis retinoic acid its pharmaceutically acceptable salts, or its pharmaceutically acceptable hydrolyzable esters is administered either orally or topically to patients sebum secretion is reduced. Therefore, the administration of this compound which acts to reduce sebum secretion and acne lesions provides a means for combatting diseases such as acne, oily hair and oily scalp. In such a manner, the administration of this compound may be used either as a prophylaxis against disorders caused by excess sebum secretion such as acne or oily scalp and hair or in their treatment.

It is known that inhibition of sebum production and/or secretion is effective in the treatment and/or prevention of disorders such as acne. Increased sebum secretion may result in such dermatological conditions as seborrhea, including dandruff, oily skin, oily hair, whiteheads and blackheads.

In accordance with this invention, the topical and oral administration of the compound of formula I, its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters are effective in treating all forms of acne such as inflammatory and non-inflammatory.

In yet another aspect of this invention it has been found that 9-cis retinoic acid, its pharmaceutically acceptable salts, or its pharmaceutically acceptable hydrolyzable esters when administered either orally or topically to patients suffering from psoriasis, it is effective in treating psoriasis. This administration reduces the effects on the skin of the disease psoriasis.

The pharmaceutically acceptable salts include any salt chemically permissible for 9-cis retinoic acid and applicable to human patients in a pharmaceutically acceptable preparation. Any such conventional pharmaceutically acceptable salt can be utilized. Among the conventional salts which can be utilized there are the base salts included, for example, alkali metal salts such as sodium or potassium, alkaline earth metal salts such as calcium or magnesium, and ammonium or alkyl ammonium salts.

In accordance with this invention the 9-cis retinoic acid can be administered in the form of its pharmaceutically acceptable hydrolyzable esters. Any pharmaceutically acceptable hydrolyzable ester can be used in the compositions and methods of this invention. Among the esters are the aromatic esters such as benzyl (OBzl) or benzyl substituted with lower alkyl, halo, nitro; or lower alkyl, e.g., t-butyl; or cyclopentyl, cyclohexyl, cycloheptyl; or 9-fluorenylmethyl.

In accordance with this invention, 9-cis retinoic acid or its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters can be provided in pharmaceutically acceptable oral, or topical composition. These pharmaceutical compositions of the invention contain said 9-cis retinoic acid or its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters in association with a compatible pharmaceutically acceptable carrier material. Any conventional carrier material can be utilized. The carrier material can be an organic or inorganic inert carrier material suitable for oral administration. Suitable carriers include water, gelatin, gum arabic, lactose, starch, magnesium stearate, talc, vegetable oils, polyalkylene-glycols, petroleum jelly and the like. Furthermore, the pharmaceutical preparations may contain other pharmaceutically active agents. Additional additives such as flavoring agents, preservatives, stabilizers, emulsifying agents, buffers and the like may be added in accordance with accepted practices of pharmaceutical compounding.

The pharmaceutical preparations can be made up in any conventional form including: (a) a solid form for oral administration such as tablets, capsules, pills, powders, granules, and the like; and (b) preparations for topical administrations such as solutions, suspensions, ointments, creams, gels, micronized powders, aerosols and the like. The pharmaceutical preparations may be sterilized and/or may contain adjuvants such as preservatives, stabilizers, wetting agents, emulsifiers, salts for varying the osmotic pressure and/or buffers.

For topical administration to the skin the aforementioned compound is preferably prepared as ointments, tinctures, creams, gels, solutions, lotions, sprays, suspensions, shampoos, hair soaps, perfumes and the like. In fact, any conventional composition utilized for application to the scalp or skin can be utilized in accordance with this invention. Among the preferred methods of applying the composition containing the agents of this invention is in the form of a gel, lotion and cream. The pharmaceutical preparation for topical administration to the skin can be prepared by mixing the aforementioned active ingredient with non-toxic, therapeutically inert, solid or liquid carriers customarily used in such preparations. These preparations should contain at least about 0.01 percent by weight, of the active ingredient based upon the total weight of the composition. Since the active ingredient, 9-cis retinoic acid is relatively non-toxic and non-irritating it may be used in topical compositions in amounts exceeding 0.15% percent. It is preferred that these preparations contain about 0.01 to 0.15% percent by weight of the active ingredient based upon the total weight of the composition. It is also preferred to apply these preparations once or twice daily to the skin. These preparations can be applied according to the need of the patient. In carrying out this invention, the active ingredient can be applied in an aqueous solution or an alcohol solution such as ethyl alcohol.

In preparing the topical preparations described above additives such as preservatives, thickeners, perfumes and the like conventional in the art of pharmaceutical compounding of topical preparation can be used. In addition, conventional antioxidants or mixtures of conventional antioxidants can be incorporated into the topical preparations containing the aforementioned active agent. Among the conventional antioxidants which can be utilized in these preparations are included N-methyl-α-tocopherolamine, tocopherols, butylated hydroxyanisole, butylated hydroxytoluene, ethoxyquin and the like. Cream-base pharmaceutical formulations containing the active agent, used in accordance with this invention, are composed of aqueous emulsions containing a fatty acid alcohol, semi-solid petroleum hydrocarbon, 1,2-ethyleneglycol and an emulsifying agent.

Ointment formulations containing the active agent in accordance with this invention comprise admixtures of a semi-solid petroleum hydrocarbon with a solvent dispersion of the active material. Cream compositions containing the active ingredient for use in this invention preferably comprise emulsions formed from a water phase of a humectant, a viscosity stabilizer and water, an oil phase of a fatty acid alcohol, a semi-solid petroleum hydrocarbon and an emulsifying agent and a phase containing the active agent dispersed in an aqueous stabilizer-buffer solution. Stabilizers may be added to the topical preparation. Any conventional stabilizer can be utilized in accordance with this invention. In the oil phase, fatty acid alcohol components function as a stabilizer. These fatty acid alcohol components are derived from the reduction of a long-chain saturated fatty acid of at least about 14 carbon atoms. Also, conventional perfumes and lotions generally utilized in topical preparation for the hair can be utilized in accordance with this invention. Furthermore, if desired, conventional emulsifying agents can be utilized in the topical preparations of this invention.

A preferred oral dosage form comprises tablets, capsules of hard or soft gelatin, methylcellulose or of another suitable material easily dissolved in the digestive tract. The oral dosages contemplated in accordance with the present invention will vary in accordance with the needs of the individual patient as determined by the prescribing physician. Generally, however, a daily dosage of from about 0.01 mg to about 3 mg per kg of body weight and preferably from about 0.025 mg to about 1.5 mg per kg of body weight of the patient is utilized. This dosage may be administered according to any dosage schedule determined by the physician in accordance with the requirements of the patient.

It is likewise within the purview of the present invention to incorporate the therapeutically active substance enumerated herein in any desired amount for enteral administration within the oral unit dosage form. It is preferred, however, to formulate preparations containing the active substance of the present invention in such a manner that each dose forms contains from about 1 mg to about 50 mg with suitable therapeutically inert fillers and diluents. It is especially preferred to incorporate such a dosage into soft gelatin capsules and tablets.

The efficacy of 9-cis retinoic acid in the use in accordance with this invention can be demonstrated in test models as described below.

A. Antitumor effects of 9-cis retinoic acid on human tumor cells lines and on experimental tumor

Inhibitory effect on growth and proliferation of human transformed epithelial cell lines

9-cis retinoic acid was tested on the human tumor cell lines SCC 15 (squamous cell carcinoma of the tongue) and A 431 (squamous cell carcinoma of the vulva). Proliferation was measured by the capacity of viable cells to reduce MTT dye [3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazoliumbromide] by a mitochon-

drial enzymatic activity (Mosmann T. Rapid colorimetric assay for cellular growth and survival: application to proliferation and cytotoxic assays. J. Immunol. Methods 65: 55-63, 1983).

Results

Human squamous cell carcinoma SCC 15 (tongue)

- Viable cells in % of controls alter 7 days of incubation	
Controls (DMSO)	100 ± 11.4
9-cis retinoic acid ($3 \cdot 10^{-7}$ M)	54 ± 7.5 $p < 0.0025$
interferon α (IFNα) (1000 U/ml)	60 ± 8.3 $p < 0.005$
9-cis retinoic acid + IFNα	20 ± 2.5 $p < 0.001$

9-cis retinoic acid in a concentration of $3 \cdot 10^{-7}$ M inhibited proliferation by 46%, in combination with IFNα even by 80%.

Human squamous cell carcinoma A 431 (vulva)

- Viable cells in % of controls alter 7 days of incubation	
Controls (DMSO)	100 ± 8.7
9-cis retinoic acid ($3 \cdot 10^{-7}$ M)	36 ± 1.8 $p < 0.001$
IFNα (1000 U/ml)	42 ± 0.9 $p < 0.0005$
9-cis retinoic acid + IFNα	23 ± 1.4 $p < 0.001$

9-cis retinoic acid in a concentration of $3 \cdot 10^{-7}$ M inhibited proliferation by 64%, in combination with IFNα even by 77%.

9-cis retinoic acid had a marked growth-inhibitory effect on the two tested human epithelial cancer cell lines.

9-cis retinoic acid was further investigated on its effect on other transformed cell lines. A proliferation assay was performed on a virus containing cell line. SKv-l1, a transformed keratinocyte cell line containing human papilloma virus 16 (HPV 16) was tested with regard to inhibition of proliferation by 9-cis retinoic acid in two experiments with four replicates. $5 \cdot 10^4$ cells/well were plated in Eagle's medium and incubated for 2 days. Direct cell counting with a hemocytometer was done before and after incubation with the retinoid in a concentration of 10^{-6} M and in corresponding DMSO controls. Growth inhibition was expressed in % compared to controls.

Result: 9-cis retinoic acid in a concentration of 10^{-6} M significantly inhibited proliferation of the human transformed keratinocytes SKv-l1 by 32.4% ($p < 0.001$).

B. Effect of 9-cis retinoic acid on tumor cell induced angiogenesis

It is now cell established that unrestricted growth of tumors is dependent on angiogenesis. Increase in tumor cell population must be preceded by an increase in new capillaries that converge upon the tumor. Therefore by inhibiting angiogenesis, tumor growth is inhibited (Folkman J. How is blood vessel growth regulated in normal and neoplastic tissue? G.H.A. Clowes Memorial Award Lecture. Cancer Res. 46: 467-473, 1986; Sidky YA and Borden EC. Inhibition of angiogenesis by interferons: Effects on tumor- and lymphocyte-induced vascular responses. Cancer Res. 47: 5155-5161, 1987).

The angiogenesis assays have been previously described (Sidky YA and Auerbach R. Lymphocyte induced angiogenesis: A quantitative and sensitive assay of the graft-vs-host reaction. J. exp Med 141: 1084-1100, 1975. Majewski S et al. Inhibition of tumour-induced angiogenesis by systemically administered protamine sulphate. Int J Cancer 33: 831-833, 1984). Two assays were used in testing 9-cis retinoic acid. In the first assay the retinoid was added in vitro to the cell line before being injected into mice. In the second assay the mice were injected intraperitoneally with the retinoid in vivo before the tumor cell line was injected intradermally.

Method: Cells of two tumorigenic cell lines, SKv-e2 and HeLa, and of a non-tumorigenic cell line, SKv-e1 were preincubated in vitro for 48 hours with 9-cis retinoic acid at a concentration of 10^{-7} M followed by cell counting and washing in TC 199 medium. The cell concentration was adjusted to $2 \cdot 10^5$ viable cells per 0.1 ml of medium and injected intradermally into X-ray irradiated, but not retinoid-treated Balb/c mice. Controls were injected with tumor cells preincubated with DMSO. The angiogenic effect was determined according to the methods referred to above.

Results

a) Effect of in vitro preincubation with 9-cis retinoic acid on angiogenic capacity of the cell lines SKv-e2 (tumorigenic), HeLa (tumorigenic) and SKv-e1 (non-tumorigenic), in Balb/c mice

Mean number of blood vessels			
	SKv-e2	HeLa	SKv-e1
Controls	34.7±3.7	32.5±2.7	26.3±1.5
9-cis retinoic acid	23.6±4.2 p <0.001	23.8±2.9 p < 0.001	25.6±2.2 p < 0.1

In contrast to the inhibitory effect of 9-cis retinoic acid on the formation of new blood vessels induced by the two tumorigenic cell lines, 9-cis retinoic acid did not inhibit angiogenesis induced by the non-tumorigenic subline.

b) Inhibition of cell-induced angiogenic effect by pretreatment of Balb/c mice in vivo by 9-cis retinoic acid.

Mean number of blood vessels			
	Control	9-cis retinoic acid	
HeLa (Tumorigenic)	28.3 ± 0.8	16.3 ± 1.8	p < 0.001
SKv-l2 (Tumorigenic)	30.3 ± 2.6	15.3 ± 1.0	p < 0.001
SKv-e2 (Tumorigenic)	31.3 ± 2.7	19.7 ± 0.6	p < 0.001
SKv-e1 (Non-Tumorigenic)	19.7 ± 3.7	24.3 ± 5.6	p > 0.1

Mice treated with 9-cis retinoic acid showed an inhibition of new blood vessel formation when injected with cells of 3 tumorigenic cell lines. There was no anti-angiogenic effect when a non-tumorigenic cell line was used.

9-cis retinoic acid inhibits in vitro and in vivo the formation of new blood vessels induced by tumor cell lines. Since neovascularisation is a prerequisite for tumor growth, 9-cis retinoic acid acts not only by a direct antitumor effect via inhibition of proliferation and/or induction of differentiation but also by an anti-angiogenic effect, inhibiting indirectly tumor growth.

C. Effect of 9-cis retinoic acid on chemically-induced skin papillomas in mice

The preventive and therapeutic effect of retinoids on chemically-induced tumors of the skin, of the respiratory, digestive and urinary tract as well as of the mammary gland is well established (Bollag W. and Hartmann HR. Prevention and therapy of cancer with retinoids in animal and man. Cancer Surveys 2: 293-314, 1983). 9-cis retinoic acid has a marked therapeutic effect on established skin papillomas of mice leading to regression of these epithelial tumors. The papilloma test is a standard test for the anti-tumor screening of retinoids.

Results

Dose mg/kg i.p.	Percent change in the average sum of the papilloma diameters per mouse	
Controls	+ 23.5 ± 2.1	
9-cis retinoid acid		
400	- 43.3 ± 2.4	p < 0.0005
200	- 24.8 ± 4.5	p < 0.0005

9-cis retinoic acid had a substantial therapeutic antitumor effect on established chemically-induced skin papillomas of mice, producing regression of this epithelial tumor.

D. Effect of 9-cis retinoic acid on antipsoriatic activity

The antipsoriatic activity can be determined by the capacity to produce a regression of chemically-induced skin papillomas in mice in the test model quoted in paragraph C. The papilloma test is a standard test for the antipsoriatic effect of retinoids (Teelmann K, Bollag W. The relevance of the mouse papilloma test as a predictor of retinoid activity in human psoriasis. Dermatologica 180: 30-35, 1990).

As can be seen from the data given in paragraph C, 9-cis retinoic acid has a marked therapeutic effect in this model for predicting antipsoriatic activity in humans.

E. Activity of 9-cis retinoic acid in acne and sebum suppression

The etiology of acne is multifactorial, with excessive sebum secretion, hyperkeratinization, and bacterial colonization playing key roles in its pathology.

The following two models have been used as a measure for anti-acne activity:

1. The human sebocyte antiproliferation assay has been shown to correlate stronlgy with compounds examined clinically in humans for acne (Doran T.I. and Shapiro S.S. Retinoid effects on sebocyte proliferation. In "Retinoids, Part B. Cell Differentiation and Clinical Applications". Methods in Enzymology, Volume 190. Ed. L. Packer, Academic Press, pp. 334-338, 1990).
2. The rhino mouse antikeratinizing assay has also been used as a measure of anti-acne activity (Mezick J.A., Bhatia M.C., and Capetola R.J. Topical and systemic effects of retinoids on horn-filled utriculus size in the rhino mouse. A model to quantify "antikeratinizing" effects of retinoids. J Invest Dermatol 83, 110-113, 1984. Mezick J.A., Bhatia M.C., Shea L.M., Thorne E.G., and Capetola R.J. Anti-acne activity of retinoids in the Rhino-mouse. In: Models of Dermatology, Maibach and Lowe (eds), Karger (Basel), volume 2, pp. 59-63, 1985).

1. Sebocyte Proliferation

I. Method

Sebaceous cells were isolated from adult human sebaceous glands, derived from facial skin removed during cosmetic surgery, and cultured on a layer of mouse 3T3 fibroblasts (Doran T.I., Baff R., Jacobs P., and Pacia E. Characterization of human sebaceous cells in vitro. J Invest Dermatol 96, 341-348, 1991). Cells were plated in medium without the test compound and then given test compound in fresh medium 24-48 hours after the initial plating. The cultures were given fresh medium, containing the test compound, every 48 hours. On the day of harvesting, the cultures were rinsed with 0.03% EDTA in PBS, to remove only the 3T3 fibroblasts, followed by incubation in 0.05% trypsin/0.03% EDTA. The cells were suspended, mixed vigorously to prepare a single cell suspension and counted in a hemocytometer. Results were determined as the amount of compound necessary to inhibit the proliferation of sebaceous cells by 50% (IC_{50}) in µM

as compared to a control culture which was treated only with diluent.

II. Results

9-cis retinoic acid was active in vitro in suppressing the proliferation of human sebocytes with an IC_{50} of 0.1 μM.

2. Rhino Mouse Utricle Reduction, Antikeratinizing Assay

I. Method

Female rhino mice (hr^{hr} hr^{hr}), 6 to 8 weeks of age, were obtained from Jackson Laboratories. Six animals per group were used. Compounds were prepared by dissolving them in acetone. The test compounds were applied to the dorsa of the mice with a micropipette. 100 μl of the test material was applied daily for 5 days for 3 consecutive weeks. The mice were sacrificed by CO_2 inhalation. A flap of skin from the dorsa was cut out and saved for histological examination. The epidermis, separated from the dermis, was placed in wire mesh histological cassettes and dehydrated in: 70%, 80%, 95%, 100% ethanol, and xylene for 2 hours at each stage. The skin samples were removed from the xylene bath and mounted on glass microscope slides. Image analysis using the Ultimage system was used to determine the mean area of the utricles. Approximately 150 utricles per mouse were analyzed.

II. Results

Effect of 9-cis retinoic acid in Reducing Rhino Mouse Utricle Size after Topical Application for Three Weeks

Compound	Dose		Utricle Size (Sq. Microns) (Mean ± SD)	% Change
	(% Solution)	(mg/kg)		
9-cis retinoic acid	0.001%	0.04	2593 ± 559	-52
	0.01%	0.4	1425 ± 167	-74
	0.1%	4.0	1210 ± 76	-78
Control	Vehicle		5420 ± 42	----

All p values were < 0.001 for comparison of compound-treated to vehicle-treated groups. Student's t-test was performed for statistical determination.

9-cis retinoic acid was active in this antikeratinizing and anti-acne assay.

F. Clinical data on the treatment of acne vulgaris patients with 9-cis retinoic acid

8 patients, 2 males and 6 females, 15 to 48 years old, with an average age of 27 years, have been treated with 9-cis retinoic acid during 1 to 3 months. Of the 8 patients, 2 were treated for 1 month, 2 for 2 months and 4 for 3 months. 5 patients had comedones, 7 had papules, 6 had pustules and 1 had nodules. 7 patients had lesions only in the face, 1 patient had lesions in the face and on the back. 9-cis retinoic acid was given in the following formulation: 0.01% of the active compound in a solution of ethanol-propyleneglycol (50/50). The solution was applied once a day, in the evening, to the regions where acne lesions were present.

Lesions (comedones, papules, pastules and nodules) were counted separately at baseline and after 1, 2 and 3 months of treatment. The percentage of decrease of total lesion count from the baseline count was determined for every patient and the mean value was calculated. The results are as follows: After 1 month the total lesion count (8 patients) had decreased by an average of 48% alter 2 months (6 patients) by 72% and after 3 months (4 patients) by 77%. Particular attention was paid to irritation of the skin. In 2 patients, at the beginning of treatment a slight erythema and slight scaling was observed which was transient and disappeared within one to two weeks in spite of continuation of treatment. The patients hardly took notice of these side effects.

Treatment of acne with 9-cis retinoic acid yielded very good results, comparable to those achieved with all-trans or 13-cis retinoic acid. The drug concentration needed for a successful topical therapy was 0.01%

and is markedly lower than that of all-trans retinoic acid or 13-cis retinoic acid where a concentration of 0.05% is necessary to achieve the same therapeutic result. Furthermore the therapeutically efficacious concentration of 9-cis retinoic acid does induce substantially fewer side effects than that of all-trans or 13-cis retinoic acid.

G. Activity of 9-cis retinoic acid in photodamage

I. Methods

Hairless mice were UVB irradiated, and, thereafter, treated topically with 9-cis retinoic acid to effect repair of the dermal damage.

Skin from the irradiated and treated area was histologically evaluated for the extent of repair. Repair was defined by the appearance of a normalized dermis extending from the epidermis down to the layer of compressed elastin. The extent of repair was reflected by the width of this zone.

The methods are described in: Bryce G.F., Bogdan N.J., Brown C.C. Retinoic acids promote the repair of the dermal damage and the effacement of wrinkles in the UVB-irradiated hairless mouse. J. Invest. Dermatol. 91, 175-180, 1988.

II. Results

Treatment	Repair Area in $mm^2 \times 10^{-3}$ ED_{50}	Wrinkling Scale O-4 ED_{50}
Control	0.21 ± 0.12	3.1 ± 0.3
9-cis retinoic acid		
10 µg	0.57 ± 0.48	2.6 ± 0.7
30 µg	0.87 ± 0.34	1.8 ± 0.3 **
100 µg	7.37 ± 2.04 **	0.3 ± 0.1 ***
200 µg	6.46 ± 1.57 **	0 ***

** $p < 0.01$ *** $p < 0.001$ vs control

H. Acute Toxicity

Acute Toxicity was determined in Füllinsdorf albino mice. 9-cis retinoic acid was suspended in rape oil and administered intraperitoneally in one single dose. The lethal dose (LD) of 10%, 50% and 90% of the mice was recorded 24 hours, 10 days and 20 days after the application of the single dose. For each group 10 mice were used.

Results (in mg/kg of the administered compound)

	24 hours	10 days	20 days
LD 10%	> 4000	1200	1200
LD 50%	> 4000	1400	1400
LD 90%	> 4000	1800	1800

The following examples illustrate pharmaceutical preparations containing the 9-cis retinoic acid as provided by the present invention. The compound 9-cis retinoic acid can also be designated by the name

(E,Z,E,E)-3,7-dimethyl-9-[2,6,6-trimethyl-1-cyclohexen-1-yl]-2,4,6,8-nonatetraenoic acid.

Example 1

Lotion (solution)		preferred
9-cis Retinoic Acid	0.02 - 0.30 g	
Propylene Glycol	5.00 - 20.00 g	10.00 g
PEG-Glyceryl Cocoate *	0.00 - 20.00 g	10.00 g
dl-α-Tocopherol	0.001 - 0.50 g	0.02 g
Ascorbyl Palmitate	0.01 - 0.20 g	0.10 g
Propyl Gallate	0.001 - 0.02 g	0.002 g
Citric acid, anhydr **	0.00 - 0.20 g	0.01 g
Isopropanol ***	40.00 - 90.00 g	50.00 g
Water, ad	100.00 g	100.00 g (resp. ml)

* or other tensides
** or other complexing agents e.g. EDTA
*** or other alcohols e.g., Ethanol

Example 2

Gel		preferred
9-cis Retinoic Acid	0.02 - 0.30 g	
Propylene Glycol	5.00 - 20.00 g	10.00 g
PEG-Glyceryl Cocoate *	0.00 - 20.00 g	10.00 g
dl-α-Tocopherol	0.001 - 0.50 g	0.02 g
Ascorbyl Palmitate	0.01 - 0.20 g	0.10 g
Propyl Gallate	0.001 - 0.02 g	0.002 g
Citric acid, anhydr **	0.00 - 0.20 g	0.01 g
Isopropanol ***	40.00 - 90.00 g	50.00 g
HPMC ****	0.50 - 5.00 g	3.00 g
Preservative *****	q.s.	q.s.
Water, ad	100.00 g	100.00 g

* or other tensides
** or other complexing agents e.g. EDTA
*** or other alcohols e.g., Ethanol
**** Hydroxypropyl Methylcellulose or other polymers e.g. neutralized Carbomer, Methyl Cellulose, Sodium. Carboxymethylcellulose
***** Preservatives e.g., Paraben esters (methyl, ethyl, propyl, butyl), Sorbic Acid, Benzoic Acid

Example 3

Cream

		preferred
9-cis Retinoic Acid	0.02 - 0.30 g	
Glycerol	0.00 - 10.00 g	5.00 g
Na_2EDTA	0.001 - 0.50 g	0.03 g
Glycerides *	5.00 - 20.00 g	10.00 g
Cetyl Alcohol	0.50 - 5.00 g	1.00 g
Stearyl Alcohol	0.50 - 5.00 g	1.00 g
Glycerol mono Stearate	1.00 - 8.00 g	4.00 g
Cetaereth **	0.50 - 5.00 g	2.00 g
dl-α-Tocopherol	0.001 - 0.50 g	0.02 g
Preservative ***	q.s.	q.s.
Water, ad	100.00 g	100.00 g

* e.g. Caprylic/Capric/Triglyceride, Caprylic/Capric/Linoleic Triglyceride, natural glycerides, as well as e.g., Propylene Glycol, Dicaprylate/Dicaprate and waxes such as Stearyl Stearate, Oleyl Oleate, Isopropyl Myristate.

** Ceteareth 5-30, or other emulsifiers such as Polysorbate 20-80, Sorbitane esters of fatty acids, fatty acid esters of PEG.

*** Preservatives e.g., Paraben esters (methyl, ethyl, propyl, butyl), Sorbic Acid, Benzoic Acid.

Example 4

Fill mass for soft gelatin capsules	
9-cis Retinoic Acid	5.00 - 50.00 mg
Oil *	1 - 3 parts
Wax mixture **	1 - 5 parts
Fill volume	1 - 6 minims

* natural vegetable oils, e.g., soy oil, peanut oil, and artificial glycerides

** composition of natural and artificial waxes or partially hydrated fats

Example 5

1. Hard Gelatine capsules containing 20 mg active substance:

Composition: One Capsule contains:

9-cis Retinoic acid	20.0 mg
Gelatine Bloom 30	70.0 mg
Maltodextrin MD 05	108.0 mg
dl-α-Tocopherol	2.0 mg
Sodium ascorbate	10.0 mg
Microcrystalline cellulose	48.0 mg
Magnesium stearate	2.0 mg
(weight capsule content)	260.0 mg

Procedure:

The active substance is wet milled in a solution of gelatine, maltodextrin, dl-α-Tocopherol and sodium ascorbate.

The wet milled suspension is spray-dried.

The spray-dried powder is mixed with microcrystalline cellulose and magnesium stearate.

260 mg each of this mixture are filled into hard gelatine capsules of suitable size and color.

Example 6

2. Tablet containing 20 mg active substance:

Composition:

Tablet kernel:	
9-cis Retinoic acid	20.0 mg
Anhydrous lactose	130.5 mg
Microcrystalline cellulose	80.0 mg
dl-α-Tocopherol	2.0 mg
Sodium ascorbate	10.0 mg
Polyvinylpyrrolidone K30	5.0 mg
Magnesium stearate	2.5 mg
(Kernel weight)	250.0 mg

Film coat:	
9Hydroxypropyl methylcellulose	3.5 mg
Polyethylenglycol 6000	0.8 mg
Talc	1.3 mg
Iron oxide, yellow	0.8 mg
Titanium dioxide	0.8 mg
(weight of the film)	7.4 mg

Procedure:

9-cis Retinoic acid is mixed with anhydrous lactose and micro-crystalline cellulose.

The mixture is granulated in water with a solution/dispersion of polyvinylpyrrolidone, dl-α-Tocopherol and sodium ascorbate.

The granular material is mixed with magnesium stearate and afterwards pressed as kernels with 250 mg weight.

The kernels are film coated with a solution/suspension of above-mentioned composition.

Example 7

Sachet containing 50 mg active substance:

Composition:

9-cis Retinoic acid	50.0 mg
Lactose, fine powder	990.0 mg
Microcrystalline cellulose	1400.0 mg
Sodium Carboxymethyl-cellulose	14.0 mg
dl-α-Tocopherol	5.0 mg
Sodium ascorbate	20.0 mg
Polyvinylpyrrolidone K30	10.0 mg
Magnesium stearate	10.0 mg
Flavouring Agents	1.0 mg
(Fill weight of a sachet)	2500.0 mg

Procedure:

9-cis Retinoic acid is mixed with lactose, microcrystalline cellulose and sodium carboxymethyl cellulose.

The mixture is granulated in water with a solution/dispersion of polyvinylpyrrolidone, dl-α-Tocopherol and sodium ascorbate.

The granule is mixed with magnesium stearate and flavoring agents.

It is filled into sachets of suitable size.

Claims

1. Pharmaceutical compositions containing 9-cis retinoic acid, a pharmaceutically acceptable salt or a pharmaceutically acceptable hydrolyzable ester thereof, and a therapeutically inert pharmaceutically acceptable carrier.

2. A composition as in claim 1 suitable for oral application.

3. A composition as in claim 1 suitable for topical application.

4. A composition as in claim 1 for the treatment of premalignant or precancerous epithelial lesions or epithelial tumors.

5. A composition as in claim 4 for the treatment of leukoplakias of the oral cavity.

6. A composition as in claim 4 for the treatment of epithelial tumors of the breast, cervix, prostate, skin, colon, bladder, esophagus, stomach, larynx, lung or oral cavity.

7. A composition as in claim 3 for the treatment of conditions associated with photodamaged skin.

8. A composition as in any one of claims 2 or 3 for reducing sebum secretion and acne symptoms.

9. A composition as in any one of claims 2 or 3 for the treatment of psoriasis.

10. A composition as in claim 2 comprising in a dosage unit from about 1 to about 50 mg of 9-cis retinoic acid, its pharmaceutically acceptable salts or pharmaceutically acceptable hydrolyzable esters.

11. A composition as in claim 3 wherein 9-cis retinoic acid, its pharmaceutically acceptable salts or pharmaceutically acceptable hydrolyzable esters is present in an amount of 0.01% to about 0.15% by weight.

12. The composition of claim 11, wherein said composition contained from about 0.02% to about 0.05% by weight of 9-cis retinoic acid, its pharmaceutically acceptable salts or pharmaceutically acceptable hydrolyzable esters.

13. 9-cis retinoic acid, its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters for use as a medicament.

14. 9-cis retinoic acid, its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters for use as a medicament suitable for oral application.

15. 9-cis retinoic acid, its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters for use as a medicament suitable for topical application.

16. 9-cis retinoic acid, its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters for use as a medicament for the treatment of premalignant or precancerous epithelial lesions or epithelial tumors.

17. 9-cis retinoic acid, its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters for use as a medicament for the treatment of leukoplakias of the oral cavity.

18. 9-cis retinoic acid, its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters for use as a medicament for the treatment of epithelial tumors of the breast, cervix, prostate, skin, colon, bladder, esophagus, stomach, larynx, lung or oral cavity.

19. 9-cis retinoic acid, its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters for use as a medicament for the treatment of conditions associated with photodamaged skin.

20. 9-cis retinoic acid, its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters for use as a medicament for reducing sebum secretion and acne symptoms.

21. 9-cis retinoic acid, its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters for use as a medicament for the treatment of psoriasis.

22. 9-cis retinoic acid, its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters for use as a medicament suitable for oral application wherein a dosage unit of said medicament comprises from about 1 to about 50 mg of active ingredient.

23. 9-cis retinoic acid, its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters for use as a medicament suitable for topical application wherein said medicament contains from about 0.01% to about 0.15% by weight of active ingredient.

24. 9-cis retinoic acid, its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters for use as a medicament suitable for topical application wherein said medicament contains from about 0.02% to about 0.05% by weight of active ingredient.

25. The use of 9-cis retinoic acid, its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters for the manufacture of a medicament for the treatment of premalignant or precancerous epithelial lesions or epithelial tumors.

26. The use of 9-cis retinoic acid, its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters for the manufacture of a medicament for the treatment of leukoplakias of the oral cavity.

27. The use of 9-cis retinoic acid, its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters for the manufacture of a medicament for the treatment of epithelial tumors of the breast, cervix, prostate, skin, colon, bladder, esophagus, stomach, larynx, lung or oral cavity.

28. The use of 9-cis retinoic acid, its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters for the manufacture of a medicament for the treatment of conditions associated with photo-damaged skin.

29. The use of 9-cis retinoic acid, its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters for the manufacture of a medicament for reducing sebum secretion and acne symptoms.

30. The use of 9-cis retinoic acid, its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters for the manufacture of a medicament for the treatment of psoriasis.

31. The use of 9-cis retinoic acid, its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters for the manufacture of a medicament for the treatment of the medical indications as defined in claims 25 to 30 wherein said medicament is suitable for oral application.

32. The use of 9-cis retinoic acid, its pharmaceutically acceptable salts and its pharmaceutically acceptable hydrolyzable esters for the manufacture of a medicament for the treatment of the medical indications as defined in claims 25 to 30 wherein said medicament is suitable for oral application is suitable for topical application.

33. The use as in claim 31 wherein a dosage unit of said medicament contains from about 1 to about 50 mg of active ingredient.

34. The use as in claim 32 wherein said medicament contains from about 0.01% to about 0.15% by weight of active ingredient.

35. The use as in claim 32 wherein said medicament contains from about 0.02% to about 0.05% by weight of active ingredient.

36. The invention as hereinbefore described especially with reference to the Examples.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 93 10 0257

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X Y	DE-A-3 827 467 (L'OREAL) 23 February 1989 * claims 1,4,10,11,17 *	1,3-9, 11-24 25-36	A61K31/20 A61K31/07
P,X	CHEMICAL ABSTRACTS, vol. 118, no. 5, 1 February 1993, Columbus, Ohio, US; abstract no. 39207c, TOYODA HITOSHI ET AL. 'PREPARATION OF VITAMIN A ACID ESTER COMPOUNDS AS ANTITUMOR AGENTS AND ULCER THERAPEUTICS FOR SKIN AND°DIGESTIVE TRACT' page 717 ;column 2 ; * abstract *	1-27, 31-36	
Y	& JP-A-04 244 076 (JPN. KOKAI TOKKYO KOHO) 1 September 1992	28-30	
X	LEUKEMIA RESEARCH vol. 10, no. 6, 1986, pages 619 - 629 A. YEN ET AL 'RETINOIC ACID INDUCED HL-60 MYELOID DIFFERENTIATION: DEPENDENCE OF EARLY AND LATE EVENTS ON ISOMERIC STRUCTURE'	13-24	
Y	* abstract * * page 622 - page 623 * * page 627 *	25-36	A61K
Y	WO-A-8 807 857 (DALTEX MEDICAL SCIENCES, INC.) 20 October 1988 * page 2-4 * * page 23-24; claims 1-3,6,7-9,12-15,18-19 *	28-31, 33,36	
Y	WO-A-900 675 (MOLECULAR DESIGN INTERNATIONAL, INC.) 28 June 1990 * page 1 - page 4; claims 1-3,6 *	25, 27-29, 32,34-36	

-/--

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 APRIL 1993	KRAUTBAUER B.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0601)

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	J. AM. ACAD. DERMATOL. vol. 6, 1982, pages 824 - 827 F.L. MEYSKENS 'STUDIES OF RETINOIDS IN THE PREVENTION AND TREATMENT OF CANCER' * the whole document * ---	25-27, 29-36	
Y	THE LANCET vol. 2, 1980, pages 224 - 226 LEVINE ET AL. 'TOPICAL VITAMIN-A-ACID THERAPY FOR CUTANEOUS METASTATIC MELANOMA' * the whole document * ---	25-27, 31-36	
Y	J. AM. ACAD. DERMATOL. vol. 9, no. 5, 1983, pages 797 - 805 W. BOLLAG ET AL. 'THE DEVELOPMENT OF RETINOIDS IN EXPERIMENTAL AND CLINICAL ONCOLOGY AND DERMATOLOGY' * the whole document * ---	25-27, 29-36	
Y	JOURNAL OF CHROMATOGRAPHY vol. 227, no. 2, 1982, pages 471 - 484 F.M. VANE ET AL. 'DETERMINATION OF 13-CIS-RETINOIC ACID AND ITS MAJOR METABOLITE, 4-OXO-13-CIS-RETINOIC ACID, IN HUMAN BLOOD BY REVERSED-PHASE HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY' * page 471 * --- -/--	25-36	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 APRIL 1993	KRAUTBAUER B.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 93 10 0257

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
P,Y	NATURE vol. 355, no. 6358, 23 January 1992, pages 359 - 361 A.A. LEVIN ET AL. '9-CIS RETINOIC ACID STEREOISOMER BINDS AND ACTIVATES THE NUCLEAR RECEPTOR RXRa' * abstract * * page 361 *	25-36	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 APRIL 1993	KRAUTBAUER B.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0601)